PATENT SPECIFICATION

651,392

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PROVISIONAL SPECIFICATION

Improvements relating to Signal Channels having a Wide Band-Pass especially for Television Receivers

We, ELECTRIC & MUSICAL INDUSTRIES LIMITED, a British Company, of Blyth Road, Hayes, Middlesex, do hereby declare the nature of this invention to be as follows:—

This invention relates to band-pass circuit arrangements, and especially but not exclusively to such circuits for the reception of television signals in which the vision and sound-signals are transmitted with a small separation in the frequency spectrum.

In television receiving circuits designed to pass vision-signals having a wide band of frequencies, the selectivity at the frequency of the sound-signals is sometimes insufficient to prevent interference of the vision-signals by the sound-signals. In order to prevent this interference, it has been suggested to provide a resonant circuit, constituting an absorption circuit, connected across one of the intervalve coupling circuits of the vision-signal receiver, the arrangements being such that this absorption circuit when tuned to the sound-frequency, absorbs signals of that frequency.

It is desirable for absorption circuits of this kind to have a narrow absorption band and it is accordingly the object of the present invention to provide such an absorption circuit.

According to the present invention there is provided a band-pass circuit arrangement which is adapted to absorb signals liable to interfere with signals to be passed, said signals to be passed having a band of frequencies, the arrangement comprising a resonant circuit constituting an absorption circuit tunable or tuned to the frequency of signals to be absorbed (which will be termed "absorption frequency,") and a composite resonant circuit including the absorption circuit as part thereof, and constituting a pass circuit for signals to be passed, the arrangement being such that while the absorption circuit is tuned to said absorption frequency, the composite circuit can be tuned or is tuned to a frequency near said absorption frequency and on the same side thereof as the mid-frequency of the band of signals to be passed.

It is found that by making the composite circuit resonant at a frequency near the absorption frequency, the absorption band of the absorption circuit is considerably narrowed.

The invention may also be defined as a band-pass circuit arrangement which is adapted to absorb signals liable to interfere with signals to be passed, the signals to be passed having a band of frequencies, the arrangement comprising a series-resonant circuit constituting an absorption circuit tunable or tuned to an absorption frequency on one side of the mid-frequency of the band of signals to be passed and a parallel resonant circuit tunable or tuned to a frequency on the same side of said mid-frequency, the arrangement being such that when said circuits are respectively so tuned they form together a composite parallel resonant circuit tuned to a frequency near said absorption frequency and on the same side thereof as said mid-frequency.

In the case of television transmissions where the carrier-frequency of the signals is higher than the carrier-frequency of the sound-signals, the composite circuit will be tuned to a frequency above the absorption frequency but below the mid-frequency.

Preferably, according to the invention the absorption circuit comprises inductance and capacitance in series, and said inductance is connected to a tapping on an inductance in said composite circuit so as to effectively increase the first said in-

[*Price* 2/-]

ductance while limiting its self-capacity. In this way the absorption band of the absorption circuit can be further limited.

In order that the said invention may be clearly understood and readily carried into effect, it will now be more fully described with reference to the accompanying drawings, in which:—

Figures 1 to 3 illustrate circuit arrangements embodying the invention.

Figures 4 to 6 illustrate modifications of parts of these arrangements, and

Figure 7 is a frequency-response curve of a circuit arrangement embodying the invention.

In each of Figures 1 to 3 an inter-valve coupling circuit of a television receiver is illustrated, said circuit serving to couple two valves 1 and 2. It will be assumed that the receiver is a stagger-tuned receiver and that the coupling circuit is designed to pass vision-signals having frequencies in the lower of the vision-signal side-bands, while signals at the sound frequency, being liable to interfere with these vision-signals, are to be absorbed.

To this end a sound frequency absorption circuit is included in the coupling circuit. The absorption circuit is a series resonant circuit comprising an inductance 3 and condenser 4 and can be tuned by means of the condenser. The coupling circuit also includes a parallel resonant circuit comprising an inductance 5 and a capacitance 6 which is provided by the stray-capacities of the valves 1 and 2. The parallel resonant circuit is tuned by means of the inductance 5. Condenser 15 is a coupling condenser and 16 is a damping resistance.

The inductance 3 is arranged to be large and the condenser capacity 4 to be small compared with the inductance 5 and capacitance 6, respectively. In this way the absorption band of circuit 3, 4 is narrowed, but in practice the extent to which it may be narrowed in this way is limited.

The series circuit 3, 4 is turned to the absorption frequency, that is the sound frequency, and in accordance with the invention the composite circuit formed by this series circuit and by the parallel circuit 5, 6 is arranged to have a parallel resonance at a frequency immediately above the absorption frequency, it being assumed that the vision-signals have a higher frequency than the sound-signals. A parallel resonance at such a frequency is achieved in the composite circuit by tuning the circuit 5, 6 by itself to a frequency below the mid-frequency of the vision-signals to be passed. This result may be explained as follows:—

If the circuit 5, 6 is one of a stagger-tuned circuit which, in the absence of the circuit 3, 4 is resonant at angular frequency ω_1, and if the circuit 3, 4 is resonant at angular frequency ω_2, the frequency of the sound-signals, then it can be shown that at frequency ω, near ω_1 and ω_2 the circuit 5, 6 has a reactance approximately equal to

$$\frac{1}{2j(\omega-\omega_1)C}$$

and the circuit 3, 4 has a reactance approximately equal to

$$2j(\omega-\omega_2)L.$$

At a frequency ω_0 at which

$$\frac{1}{2(\omega_0-\omega_1)C}=2(\omega_0-\omega_2)L.$$

these reactances are equal, and opposite in sign, so that a parallel resonance occurs for the composite circuit. In order that the frequency of this parallel resonance may be immediately above the absorption frequency ω_2, the equation shows that ω_0 must be greater than ω_1.

It follows, therefore, that in a stagger-tuned receiver, the circuit 5, 6 across which the absorption circuit 3,4 is connected is tuned by itself to a frequency below the frequency of the vision-signals in the lower side-band which in this case are the signals to be passed by the inter-valve coupling circuit. Preferably, the circuit 5, 6 is tuned to as near the absorption frequency as other considerations allow.

In Figure 7, the curve 8 is a frequency-response curve for a vision-receiver having an absorption circuit according to the present invention. The curve 9 is a similar curve for a vision-receiver without such an absorption circuit. The curve 10 is the response curve obtained for a vision-receiver with an absorption circuit but not designed according to the invention. It will be seen that the invention affords a narrow absorption band, sharply limited especially on the side on which lies the mid-frequency of the signals to be passed.

As stated, the inductance 3 is arranged to be large in relation to the inductance 5 and it is desirable to make it as large as possible, since this enables the frequency ω_0 to be close to ω_2. The maximum useful value of inductance 3 is, however, limited by its self-capacity. Figure 2 illustrates an arrangement in which, in order to in-

crease the effective value of inductance 3 whilst limiting its self-capacity, it is connected to a tapping on the inductance 5. This arrangement increases the effective value of inductance 3 by a multiplying factor n^2, where n is the transformation ratio of the tapped inductance 5.

It is convenient to use a common aerial for the vision and sound signals and it is then the practice to connect the sound receiver to some point of the vision receiver where there are sound signals of suitable amplitude. Figure 3 shows an arrangement in which the sound receiver is connected across the condenser 4 of the absorption circuit 3, 4. The circuit is not only resonant at the sound frequency, but it tends to discriminate against vision signals. The connection is made across the condenser 4 because the potential across the condenser is very considerably greater than the potential across the complete circuit. The condenser 11 is inserted in the lead 7 to the sound receiver, as shown, to reduce the loading on the absorption circuit. In practice it is possible to draw sufficient energy for a commercial sound receiver without appreciably affecting the frequency-response curve or the sensitivity of the vision receiver.

Figures 4 to 6 illustrate alternative connections for the sound receiver. In Figure 4, the condensers 4 and 11 are replaced by two condensers 12 and 13 in series, and the lead 7 is taken from the junction between them. In Figures 5 and 6 the positions of the inductance 3 and condenser 4 have been interchanged, and the lead 7 is taken in one case from between the components, 3, 4, a condenser 14 being inserted in the lead to reduce the loading. In the other case the lead is taken from a tapping in the inductance 3. By choosing components of suitable value adequate sound output can be obtained without appreciably affecting the frequency-response curve of the vision receiver.

Whilst the invention is particularly suitable for use in television receivers it will be understood that the invention is generally applicable to band-pass circuits embodying absorption circuits for the rejection of interfering signals.

Dated this 1st day of July, 1946.

F. W. CACKETT,
Chartered Patent Agent.

COMPLETE SPECIFICATION

Improvements relating to Signal Channels having a Wide Band-Pass especially for Television Receivers

We, ELECTRIC & MUSICAL INDUSTRIES LIMITED, a British Company, of Blyth Road, Hayes, Middlesex, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to signal channels having a wide pass band and especially but not exclusively to such channels for the reception of television signals in which the vision and sound signals are transmitted with a small separation in the frequency spectrum.

In television receivers a signal channel comprising a plurality of stagger-tuned coupling circuits connected in cascade is sometimes employed in the vision channel in order to pass the vision signals to successive stages of the receiver said vision signals having, as is well-known, a wide band of frequencies. However, the selectivity of such an arrangement at the frequency of the sound signals is sometimes insufficient to prevent the sound signals from interfering with the vision signals and in order to prevent this interference it has been proposed to employ in one or more of the coupling circuits, a resonant circuit tuned to the sound frequency and arranged to attenuate sound signals in the vision channel. However, while such further resonant circuits satisfactorily attenuate the sound signals, they are liable to cause a reduction in the pass band of the channel.

The object of the present invention is to reduce this liability.

In accordance with the present invention there is provided a signal channel comprising a purality of stagger-tuned coupling circuits arranged in cascade to give an overall wide pass band, wherein one of the coupling circuits contains a resonant circuit self-tuned to an interfering frequency at one side of the pass band and arranged to cause a large attenuation of signals of said frequency in said channel, and wherein said coupling circuit as a whole, including the off-resonance reactance of said resonant circuit, is tuned towards the end of the pass band near said frequency.

In Patent Specification No. 514,064 there is described a band pass filter comprising tuned primary and secondary parallel resonant circuits each tuned to approximately the same frequency and so coupled and damped as to have a substantially flat-topped selectivity characteristic over a desired pass band, and a rejector network including a parallel resonant circuit tuned to a frequency which is outside but close to the pass band. At frequencies in the pass band, the rejector network presents a capacity or an inductance to the primary circuit, depending upon the side of the pass band at which its resonant frequency lies, and the tuning of the primary circuit is adjusted to tune the primary circuit, including the inductance or capacity presented by the rejector network, to the mid-point of the pass band. The present invention as defined in the preceding paragraph and claimed hereinafter in Claim 1 is distinguished from the above-mentioned prior Specification in that the coupling circuit containing the resonant circuit which is self tuned to an interfering frequency, is one of a plurality of stagger-tuned coupling circuits and is tuned as a whole (including the off-resonance reactance of said resonant circuit) towards the end of the overall pass band of the stagger-tuned circuits near the interfering frequency.

In order that the invention may be clearly understood and readily carried into effect, it will now be more fully described with reference to Figures 1 to 6 of the drawings accompanying the Provisional Specification, in which:—

Figures 1 to 3 illustrate examples of coupling circuits for signal channels in accordance with the invention,

Figures 4 to 6 illustrate modifications of these examples.

Reference will also be made to the accompanying drawings the Figures in which have for convenience been numbered 8 to 11 and wherein:—

Figure 8 shows frequency response curves which are explanatory of the invention, and

Figures 9, 10 and 11 illustrate further examples of coupling circuits for signal channels according to the invention.

Referring to Figures 1 to 3, each illustrates a coupling circuit employed as an inter-valve coupling of a television receiver and it will be assumed that the valves 1 and 2 are radio-frequency amplifying valves and that they are coupled by said coupling circuit which forms one of a plurality of stagger-tuned circuits coupling a plurality of valves in cascade. It will also be assumed that the receiver is designed to receive television transmissions in which the vision signals are transmitted on a carrier wave of a frequency of 45 Mc/s., the accompanying sound signals being transmitted on a carrier wave of a frequency of 41.5 Mc/s. It is, moreover, desired that the coupling circuit shown should have its maximum response at the lower side band frequency of the vision signals, say at 42 Mc/s., while attenuating signals at the sound frequency in the vision channel, other coupling circuits in the radio frequency amplifier being tuned to the vision carrier frequency and the upper side band frequency, as is customary in stagger-tuned arrangements. The coupling circuit illustrated is connected between the anode of the valve 1 and the control electrode of the valve 2 and comprises a series resonant circuit comprising an inductance 3 and a condenser 4, and a parallel resonant circuit comprising an inductance 5 and capacity C which is provided by the stray capacities of the valves 1 and 2. The series resonant circuit can be tuned by means of the condenser 4 and the parallel resonant circuit can be tuned by means of the inductance 5. Condenser 15 is a coupling condenser and the anode of the valve 1 is also connected to a damping resistance 16 which is earthed via a radio frequency bypass condenser 17, and to a suitable positive d.c. potential via a resistance 18. The other connections to the valves 1 and 2 are not shown since they are well known and not relevant to the present description.

The series resonant circuit 3,4 is tuned to 41.5 Mc/s., i.e., to the frequency of the sound signals. The parallel resonant circuit 5, 6 on the other hand is tuned to such a frequency that it serves to tune the coupling circuit as a whole, including the off-resonance reactance of the series resonant circuit 3, 4, to a parallel resonance at a frequency very near the sound frequency, say at 42 Mc/s. In this way the absorption band of the series resonant circuit 3, 4 can be narrowed and the pass-band of the coupling circuit illustrated and hence of the stagger-tuned frequency amplifier caused to extend more closely than would otherwise be the case to the sound frequency. This may be explained as follows:—

If the parallel resonant circuit 5, 6 is resonant by itself at angular frequency ω_1, and if the series resonant circuit 3, 4 is resonant by itself at angular frequency ω_2, the frequency of the sound signals, then it can be shown at a frequency ω near ω_1 and ω_2, the circuit 5, 6 has a reactance approximately equal to

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$$\frac{1}{2j(\omega-\omega_1)C}$$

and the circuit 3, 4 has a reactance approximately equal to

$$2j(\omega-\omega_2)L.$$

At a frequency ω_0 at which

$$\frac{1}{2(\omega_0-\omega_1)C}=2(\omega_0-\omega_2)L.$$

these reactances are equal, and opposite in sign, so that a parallel resonance occurs for the coupling circuit as a whole. In order that the frequency of this parallel resonance may be immediately above the frequency ω_2, the equation shows that ω_0 must be greater than ω_1. It will be appreciated that there will be a second parallel resonance for the coupling circuit as a whole at a frequency ($\omega^1{}_0$ say) below ω_2, symmetrically disposed about the value $\frac{\omega_1+\omega_2}{2}$ with reference to ω_0. The value of ω_0 can be brought most closely to the value ω_2 by tuning the parallel resonant circuit 5, 6 by itself to a frequency lower than ω_2. However in some cases as for example where it is desirable for $\omega^1{}_0$ also to be close to the frequency of the interfering signals, it may be desirable to tune the parallel resonant circuit 5, 6 to substantially the same frequency as the interfering signals, i.e., so that $\omega_1=\omega_2$ substantially.

The inductance 3 is arranged to be large and the condenser 4 to be small compared with the inductance 5 and the capacity 6 respectively and it is desirable to make the inductance 3 as large as possible since it is also a factor which determines how close the frequency ω_0 can be brought to ω_2. The maximum useful value of the inductance 3 is however limited by its self-capacity and Figure 2 illustrates an arrangement in which in order to increase the effective value of the inductance 3 whilst limiting its self-capacity it is connected to a tapping on the inductance 5. This arrangement increases the effective value of the inductance 3 by multiplying factor n^2 where n is the transformation ratio of the tapped inductance 5.

In Figure 8 there are shown, for purposes of comparison, idealised frequency-response curves for the vision channels of three television receivers, each employing five stages of radio frequency amplification with six coupling circuits in a stagger-tuned arrangement, two of the coupling circuits in each case being tuned below the carrier frequency of the vision signals, two being tuned to the carrier frequency and two above the carrier frequency. The curve 8 shows the response of a receiver in which each of the coupling circuits tuned below the vision carrier frequency is similar to the circuit described with reference to the Figure 2, the parallel resonant circuit 5 and 6 and series resonant circuit 3, 4 being together tuned to a parallel resonance at 42 Mc/s. The peak 23 is due to the parallel resonance of the coupling circuit as a whole, in each of the last-mentioned circuits, at a frequency lower than the sound frequency. The curve 9 shows the response of a receiver not employing sound attenuating circuits, and curve 10 shows the response of a receiver in which each of the coupling circuits tuned below the vision carrier frequency comprises a parallel resonant circuit tuned by itself to 42 Mcs., and a series resonant circuit in shunt therewith and tuned to sound frequency. The peak 24 in the curve 10 is due to a parallel resonance of the coupling circuit as a whole in each of the last-mentioned two circuits, and it corresponds to the peak 23 in the curve 8, but it lies more closely to the frequencies of maximum response in other circuits of the channel and it is therefore more accentuated than the peak 23. In the receiver having the response curve 10 the coupling circuits which comprise a parallel resonant circuit shunted by a series resonant circuit have another parallel resonance at a frequency above both the sound frequency and the frequency to which the parallel resonant circuit is tuned by itself. This other parallel resonance is responsible for the curve 10 extending beyond the curves 8 and 9 at frequencies above 46 Mc/s., and this boosting of some frequencies is sometimes undesirable. It can be seen that compared with curve 10 the curve 8 has an absorption band which is more sharply limited on the higher frequency side of the sound frequency, so that the passband extends more closely to the sound frequency.

It is convenient to use a common aerial for the vision and sound signals and to connect the sound receiver to some point of the vision receiver where there are sound signals of suitable amplitude. Figure 3 shows an arrangement in which the sound receiver is connected across the condenser 4 of the series resonant circuit 3, 4 via lead 7. The circuit 3, 4 is not only resonant at the sound frequency but it tends to discriminate against vision

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signals. A condenser 11 is inserted in the lead 7 to the sound receiver, as shown, to reduce the loading on the series resonant circuit 3, 4 it being found possible in practice to draw sufficient energy from the circuit 3, 4 for a commercial sound receiver without appreciably affecting the frequency-response curve or the sensitivity of the vision receiver.

Figures 4 to 6 illustrate alternative connections for the sound receiver. In Figure 4, the condensers 4 and 11 are replaced by two condensers 12 and 13 in series, and the lead 7 is taken from the junction between them. In Figures 5 and 6 the positions of the inductance 3 and condenser 4 have been interchanged, and the lead 7 is taken in one case from between the components 3, 4 a condenser 14 being inserted in the lead to reduce the loading. In the other case the load is taken from a tapping in the inductance 3.

Instead of employing a series resonant circuit for attenuating the sound signals a parallel resonant circuit can be employed as shown in Figures 9 to 11. In Figure 9 a coupling circuit is illustrated similar to that shown in Figure 1, the series resonant circuit 3, 4 being however, replaced by a parallel resonant circuit comprising an inductance 19 and a condenser 20 the circuit 19, 20 being connected in series with the control electrode of the valve 2, to which the coupling circuit is arranged to apply the vision signals. The circuit 19, 20 is tuned to 41.5 Mc/s., that is to sound frequency and it therefore serves to reject sound signals. The circuit 5, 6 19 and 20 is again tuned as a whole to a parallel resonance at 42 Mc/s, at this frequency circuit 19, 20 being capacitative. Figures 10 and 11 illustrate modifications of this latter arrangement designed to reduce the stray capacity to earth across the coupling circuit due to the circuit 19, 20 being connected in the lead 21 to the control electrode of the valve 2. In Figure 10 the circuit 19, 20 is not directly connected in the lead 21 but is coupled to said lead via coil 22 whilst in Figure 11 only part of the inductance 19 is connected in the lead 21 as shown.

The coupling circuits illustrated in Figures 1 to 6 are preferred to those illustrated in Figures 9 to 11 since the latter circuits are less convenient and they cannot be so easily arranged to provide a selective sound output which can be employed in a sound receiver, and in addition difficulty may be experienced on account of the transformer action between the capacity 6 and the effective capacity of the circuit 19, 20 at frequencies above the sound frequency.

Whilst the invention is particularly suitable for use in television receivers it will be understood that the invention is generally applicable to signal channels comprising a plurality of stagger-tuned coupling circuits arranged in cascade.

In Claim 1 of Patent Specification No. 516,252 there is claimed apparatus for receiving television and like signals of the type wherein the sound and vision channels contain in common the first frequency changer and comprising in the vision channel after the last common part of the sound and vision channels, a band-pass filter, coupling two stages, by the interaction of whose elements the attenuation becomes infinite for a single frequency at or close to f_s (the I.F. frequency conveying the sound signals) and the attenuation becomes zero over a finite range including most or all of the frequencies f_v (the I.F. conveying the vision signals).

Having now particularly described and ascertained the nature of the said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. A signal channel comprising a plurality of stagger-tuned coupling circuits arranged in cascade to give an overall wide pass band, wherein one of the coupling circuits contains a resonant circuit self-tuned to an interfering frequency at one side of the pass band and arranged to cause a large attenuation of signals of said frequency in said channel, and wherein said coupling circuit as a whole, including the off-resonance reactance of said resonant circuit, is tuned towards the end of the pass band near said frequency.

2. A signal channel comprising a plurality of stagger-tuned coupling circuits arranged in cascade, substantially as herein described with reference to any of Figures 1 to 6 and 9 to 11 of the drawings.

3. A television receiver for receiving television signals in which the vision and sound signals are transmitted with a small separation in the frequency spectrum, having for the vision signals a signal channel according to claim 1 or 2, said resonant circuit being tuned to the frequency of the sound signals, to cause a large attenuation of sound signals in said channel.

4. A television receiver according to Claim 3, wherein a sound receiver is connected to said resonant circuit at a point where sound signals of a suitable amplitude can be obtained.

Dated this 10th day of June, 1947.

F. W. CACKETT,
Chartered Patent Agent.

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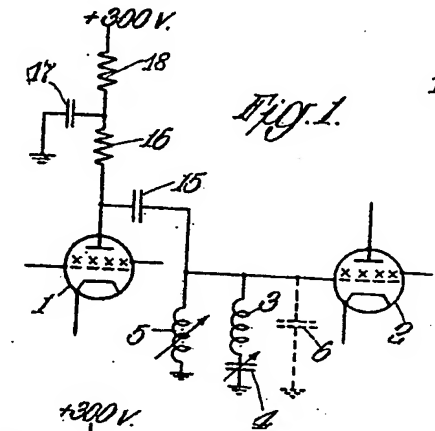


Fig.1.

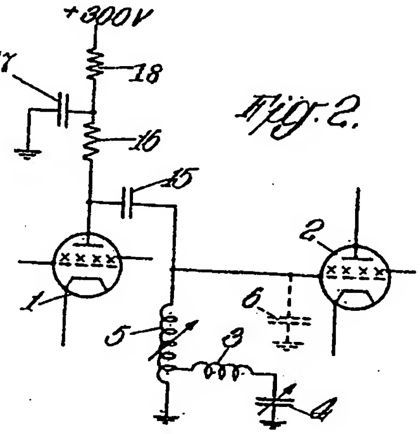


Fig.2.

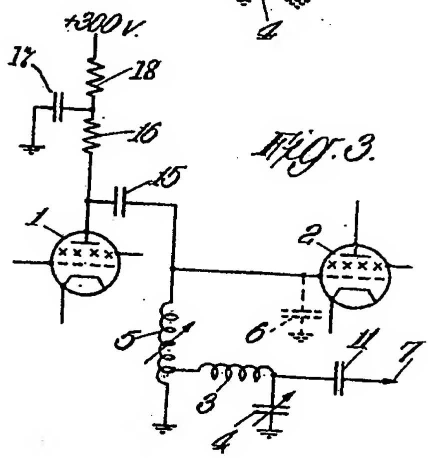


Fig.3.

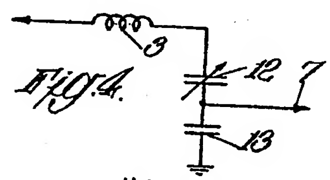


Fig.4.

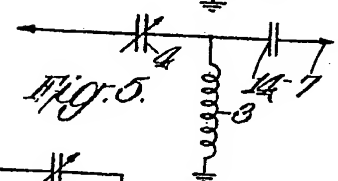


Fig.5.

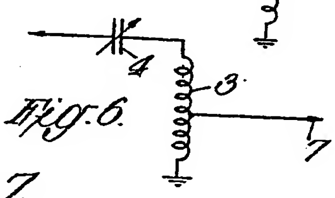
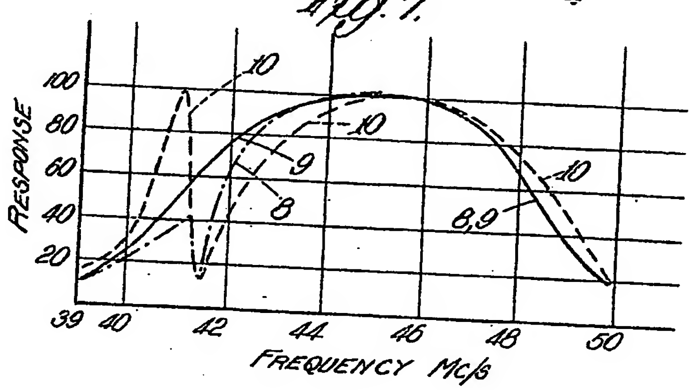


Fig.6.

Fig.7.



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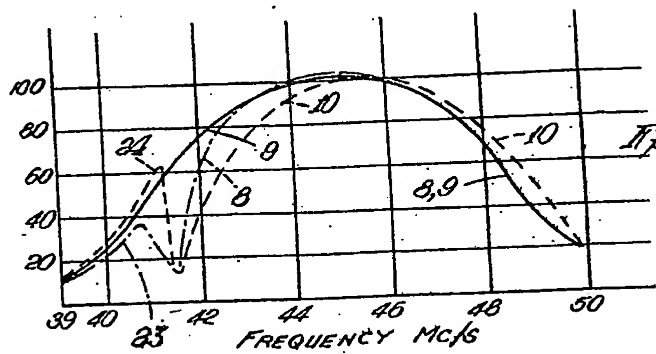

Fig. 8.

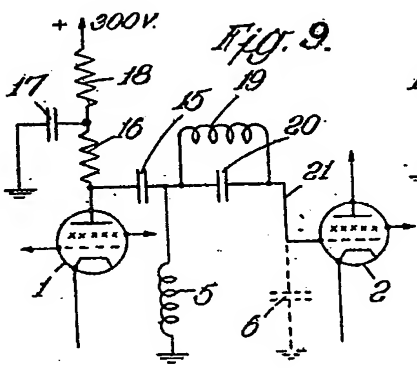

Fig. 9.

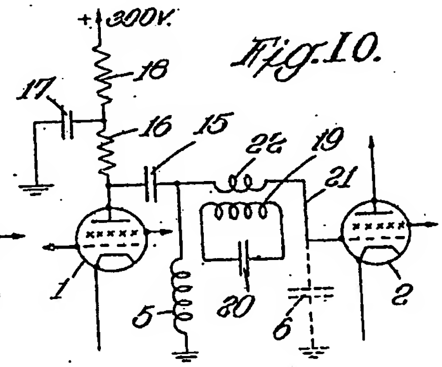

Fig. 10.

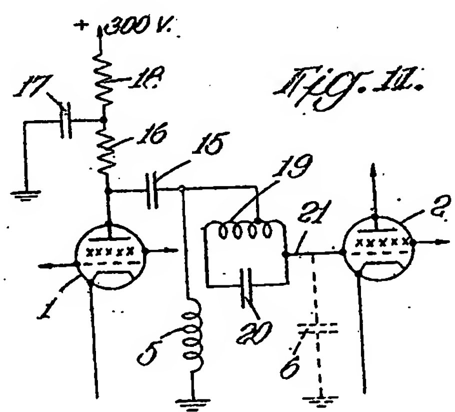

Fig. 11.

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